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# 一种混合CBCT成像系统标定方法

# A hybrid calibration method for CBCT imaging system

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中文摘要：

目的 建立一种混合锥形束CT（CBCT）成像系统标定方法，以提高CBCT成像系统参数标定精度，突破现有算法须已知标定模型中各小球相对中平面位置的限制。方法 针对CBCT成像系统建立坐标系，推导光锥不同旋转角度下标定模型中小球中心空间坐标与其在投影图像中投影平面坐标之间的几何关系，提出解析+迭代混合标定方法。将标定模型置于CBCT成像系统中，获取各个旋转角度下的投影图像；提取投影图像中各小球投影的质心坐标，套用上述方法计算出标定参数。对小鼠标本模型进行相同扫描，采用已求标定参数用FDK算法进行3D重建。结果 解析+迭代混合法对于成像系统参数$D$的标定精度较高；参数$R$的标定不直接受$D$的影响。结论 解析+迭代混合法可提高部分成像参数的标定精度，且突破了须事先知晓小球相对于中平面的空间位置及受旋转半径影响较大的限制。

英文摘要：

**Objective** To establish a hybrid calibration method for CBCT (cone-beam CT) imaging system, in order to improve calibration accuracy of CBCT imaging system, and to break the restriction of existing algorithm that positions of the balls (in the calibration model) relative to mid-plane must be known. **Methods** A coordinate system was established for CBCT imaging system. The geometric relationship between spatial coordinates of a sphere center and the corresponding projection coordinates in the imaging plane was derived for different X-ray beam rotation angles. A hybrid calibration approach of analytical and iterative methods was proposed. A calibration model was placed in the CBCT imaging system, and a sequence of projection images were acquired. The projection images were then processed to extract centroid coordinates of the sphere shadows. The calibration parameters were then computed with the hybrid calibration approach on the basis of centroid coordinates. Through FDK algorithm, the calibration parameters were used to reconstruct a 3D model of rat specimen based on the projection images. **Results** The proposed hybrid approach was proved accurate for calibrating imaging parameter *D*. Calibration parameter *R* was not influenced by *D* directly. The ball rotational radius resulted in a negligible effect on calibration accuracy. The knowledge of spheres' spatial positions relative to the mid-plane was no more necessary. **Conclusion** The proposed hybrid approach can be used to enhance accuracy of some certain calibration parameters. Besides, the approach overcomes the limitation of the existing algorithm if the positions of calibration spheres relative to the mid-plane are known beforehand and the calibration accuracy subject to spheres rotational radii.

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